PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Motor-Driven Drill for Placing Explosive Charges in Seismic Prospecting

We, JERSEY PRODUCTION RESEARCH COMPANY, a corporation duly organized and existing under the laws of the State of Delaware, United States of America, of Tulsa, Oklahoma, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to seismic prospecting for drilling for ore in water-submerged earth formations.

The problems associated with seismic prospecting in water-covered areas are accentuated by the difficulty in placing seismic sources, such as explosive charges, sufficiently deep in the earth to minimize multiple reflections between the water's surface and the ocean floor, and to minimize the extraneous elastic waves generated as a result of the sudden displacement of a considerable volume of water. It has been found that these difficulties can be overcome to a large extent when the explosive charge is placed at a considerable depth beneath the floor of the water-covered area. The apparatus used heretofore has also been unduly cumbersome and complicated, and not particularly adapted to the physical abuse thereof that is inherent in seismic operations.

Since seismic prospecting in submerged areas is expensive, the earth-boring apparatus for placing seismic charges should drill rapidly and should be capable of being transported quickly from one drilling locale to another. Further, the apparatus should operate satisfactorily with a minimum amount of preventive maintenance. To minimize damage to earth-boring equipment, the drilling apparatus should be capable of being removed from the area of the explosive charge when the charge is detonated, along with as much as possible of the apparatus other than the explosive charge itself.

The object of this invention is to provide earth-boring apparatus for seismic surveying in submerged areas that is capable of rapidly drilling boreholes to 100 feet or more and placing explosive charges therein, and to provide simple, rugged earth-boring apparatus for seismic surveying in submerged areas that is capable of withstanding considerable abuse with a minimum amount of maintenance.

Reference is made to the accompanying drawings in which:

Fig. 1 is a schematic representation showing the relationship between the underwater drilling apparatus and a ship from which drilling operations are conducted;

Fig. 2 is an elevation of a portion of the earth-drilling apparatus showing the water-driven turbine that has been found particularly useful with the invention;

Fig. 3 is an elevation, partially in cross-section, of the earth-drilling and charge-planting apparatus according to the invention.

Fig. 4 is an elevation partially in cross-section, showing a preferred apparatus for coupling together the bit and drive shaft of the earth-boring apparatus shown in Figs. 2 and 3.

According to the invention a motor preferably powered by pressurized water from an external source, such as a pump on the boat from which drilling operations are conducted, is detachably coupled to an expendable earth-boring bit. A water-driven turbine is enclosed in a casing, at the bottom end of which are secured an explosive charge receptacle or container and a container for cap-wire for detonating the charge. Secured to the explosive charge container at the bottom end thereof, are a plurality of flexible, upward extending barbs which permit the explosive-charge container to be lowered through earth formations, but which oppose upward movement of the charge container after it has been lowered into the earth. Means are provided for supporting the weight of the cap-wire container

and the explosive-charge container while the apparatus is moving downward through the earth, but which yields to pressure greater than the weight of the two containers to permit the charge container to slip off the lower end of the casing. Means are further provided for retaining the cap-wire on the casing after the charge container has been slipped off the lower end thereof.

According to one feature of the invention, the detachable expendable bit is secured to the turbine shaft by means of a deformable, compressible member fitting about a shaft connected to the bit and which is fitted within an exclosed extension of the turbine shaft. A piston member at the upper end of the deformable member bears against the deformable member when water pressure is applied to the upper end of the hollow turbine so that the deformable member squeezes against both the drill bit shaft and the extension of the turbine shaft, to provide a substantially rigid coupling therebetween. As soon as the water pressure is removed, the deformable member reverts to its original shape, allowing the bit to be released upon upward movement of the turbine shaft.

With reference to Figs. 1 to 3, there is a boat 1 upon which is supported a pump 3 coupled to a hose 9 wound on reel 5 and connected to earth-boring apparatus 12 by means of clamp 17, securing the water hose 9 to neck 15 of motor 13. The motor 13 is preferably water-powered, although it may be electrically powered if desired.

The motor has a drive shaft 27 coupled to a detachable bit 61 including blades 29 and 31. At the lower end of a reduced section of the motor casing are secured containers 24 and 19 for a dynamite charge and a coil of detonator wire or cap-wire, respectively. At the lower end of the charge container 24 are secured a plurality of flexible barbs 25 which permit the dynamite charge to be lowered into the earth without substantial opposition, but which very effectively opposes upward movement of the charge container as soon as it has been lowered into the earth. The water-covered earth's surface into which the bit is to drill is shown at 33.

Figs. 2 and 3 show in greater detail the water-powered motor and the explosive charge planting apparatus. Fitting within the interior of motor casing 13 is an interior casing 41 supporting stator blades 37 of a multi-element turbine type water-motor. Between every other stator blade 37 is a rotor blade 39 which is affixed to turbine drive shaft 27 by a friction fit or other suitable means. Within every other stator there is a water-lubricated rubber bearing, such as is commonly used on shafts of boats, so that the drive shaft 27 may rotate freely without danger of binding. A suitable motor of this type has a speed of 3500 rpm and uses 92 gallons of water per minute.

At the lower end of the motor casing below the stator blading member is secured a casing extension including a snout 21 to which is secured an explosive charge container 24 and a cap-wire container 19. An annular stop member 43 affixed to the snout 21 prevents upward movement of the cap-wire container and the charge container while the apparatus is drilling downwardly into the earth. Barbs 25 are affixed to the lower end of the explosive charge container. These barbs may be of 14 gauge spring steel, having dimensions 1″ × 10″.

The lower end of the explosive charge fits loosely about an annular stop 53, the purpose of which is to prevent the cap-wire can from slipping off the lower end of snout 21 when the apparatus is being raised after the drilling operation has ceased. As shown, the cap-wire container is of somewhat smaller inside diameter than the inside diameter of the explosive charge container. The wire 45 within the cap-wire container 19 is connected to a cap 47 within charge container 24. The cap-wire is wound so that it will readily pay out without breaking as the cap-wire container is raised to the surface of the water. The bottom of container 19 is open, in which case a latch 20 is used to keep the cap-wire spool within container 19.

The cap-wire container 19 and explosive charge container 24 are supported by retaining means 59 which will support the weight of the two containers but which will yield against the retarding forces of barbs 25 as the motor and casing are withdrawn upwardly to permit explosive charge container 24 to slip off the lower end of snout 21. Retaining means 59 may be a frangible lock washer or a very weak snap washer fitting into an annular groove 57 at the lower end of snout 21.

At the lower end of motor-driven shaft 27 there is secured an expendable bit 60 comprising a shaft 61 having a square or rectangular cross-section, and a pair of straight-edged blades 29 and 31 at right angles to and vertically disposed with respect to each other. Shaft 61 is secured to motor drive shaft 27 by means of a reduced diameter extension 63 fitting into a bore within the lower end of motor shaft 27. A shear pin 65 extending through the motor-shaft 27 and reduced diameter extension 63 joins the two members together. In order to reduce counter torques exerted on blades 31 and 29 by the earth through which the blades cut blade 31 has only half the length of blade 29; thus blade 31 will bore a hole having one diameter, which hole will subsequently enlarged by blade 29. Each of the two blades has a very small pitch with respect to a plane perpendicular to the axis of drive shaft 27, the blades having pitch of about 1/8″ for a blade diameter of about 2″. Water coming through the lower end of snout 21 has a very low velocity and is not

the stem of the bit when the stem projects into said casing responsive to said increase in fluid pressure within said motor-driven shaft to firmly bind the stem of the bit to said first shaft.

6. Apparatus according to claim 5, wherein said packing means resumes substantially its original shape upon removal of said fluid pressure to release said second shaft or stem from said motor-driven shaft.

7. Apparatus according to Claim 6, including piston means within said chamber between said first shaft and said packing means and bearing against said compressible packing so as to distort said packing upon application of fluid pressure within said motor driven shaft to firmly bind the stem of the bit to said first shaft.

8. Apparatus as claimed in Claim 1, substantially as herein described with reference to the accompanying drawings.

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particularly effective to wash away cuttings; however, it has been found that with the particular bit and configuration shown, very rapid drilling may be effected without danger of fouling of the bit by earth cuttings.

In operation, pressurized water from pump 3 drives the rotor members of water-motor 12 at a very high speed. The apparatus has been found effective for drilling speeds as high as 10 feet per minute through hard sand and shale.

After the charge has been lowered to the desired depth in the earth, the direction of rotation of reel 5 is reversed so as to withdraw the motor 12 upwardly. Explosive charge container 24 slides off the lower end of snout 21 and shear pin 65 shears, releasing expendable bit 60. Cap-wire can 19 is withdrawn upwardly inasmuch as stop member 53 prevents it from sliding off the end of snout 21. When the cap-wire can reaches the surface, the explosive charge can be detonated at any convenient time.

Certain earth formations have been found to offer such high resistance to drilling operations that the simple bit-coupling device depicted in Fig. 3 is unsuitable for drilling therethrough. Shear pin 56 cannot be particularly strong inasmuch as the bit is to be detached from the drive shaft 27 and so, when drilling through shale or through hard earth formations, the shear pin usually gives way. The apparatus of Fig. 4 has been found to provide suitable coupling under all drilling conditions. Turbine shaft 27 is coupled to bit shaft 61 by means of a casing member 71 threadingly engaging the lower end of shaft 27. Turbine shaft 27 must be hollow so that water pressure at the upper end 35 thereof (see Fig. 2) is transmitted therethrough to casing 71. A deformable member 79 of rubber or a rubber-like material surrounds bit shaft 61, but is in very loose engagement therewith so that the bit shaft will slide readily out of casing 71. The casing has a retaining member 81 threadingly engaging the interior of the lower end thereof so as to support deformable member 79. A weak shear pin 82 is provided to hold shaft 61 as the assembly is lowered to the initial drilling position. The pin 82 should shear readily when the bit is struck by charge container 24 after it slips off snout 21. A piston 75 bears against the upper end of deformable member 79 and small relief ports 73 are provided in the casing 71 between the upper end of deformable member 79 and the lower end of shaft 27. Piston 75 is adapted for bilateral movement within casing 71. Water pressure exerted on the upper face of piston 75 causes the piston to bear against deformable member 79 so that it effectively squeezes shaft 61 to provide a substantially rigid connection between shaft 61 and casing 71. In order to ensure against counter-rotation of shaft 61 as drive shaft 27 is rotated by motor 12, the shaft 61 should be of square or rectangular cross-section, as should the central bore of deformable member 79.

WHAT WE CLAIM IS:—

1. Apparatus for planting an explosive charge in the earth comprising a motor driven shaft enclosed in a casing having an open end through which said shaft may project for coupling to a detachable bit; first stop means on said casing near said open end thereof; a receptacle for said explosive charge having flexible barbs affixed thereto permitting downward movement of said receptacle as said receptacle is lowered into the earth, but thereafter opposing upward movement of said receptacle; a container for reelable cap-wire for connection to a cap within said receptacle to detonate said explosive charge, said receptacle and container being fitted about said casing so that said receptacle may slide over said first stop means but said container is prevented from sliding over said first stop means, said receptacle being between said open end and said container; an annular groove in said casing for receiving yieldable retaining means for supporting the weight of said receptacle and said container while said receptacle is being lowered into the earth, but yieldable under opposition of said barbs to allow said receptacle to slide off said casing when said casing is withdrawn upwardly from the earth.

2. Apparatus according to claim 1 having a water-driven turbine motor for rotating said shaft, said turbine motor comprising first alternate fixed reaction blade section fixedly held by said casing, and alternate rotatable blade sections connected to said shaft; a source of fluid pressure, and means coupling said source of fluid pressure to said casing to energize said turbine motor, the discharge end of said turbine motor exhausting through said open end of said casing.

3. Apparatus according to claim 1 or 2 in which the yieldable retaining means is a lock ring.

4. Apparatus according to any preceding claim having an expendable bit coupled to said shaft on an end thereof by means including shear pin means said bit having spaced-apart, straight-edge cutting edges revolving in planes normal to the axis of said shaft.

5. Apparatus according to any one of Claims 1—3 in which the motor-driven shaft is hollow along its length and there is provided coupling means for coupling said motor-driven shaft to the stem of the bit responsive to fluid pressure within said motor-driven shaft, comprising a casing attached to one end of said motor-driven shaft and enclosing a chamber communicating with the interior of said motor-driven shaft; an opening within said casing through which the stem of the bit may project; and means including compressible packing means within said casing surrounding

852,428 COMPLETE SPECIFICATION
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Fig. 1.

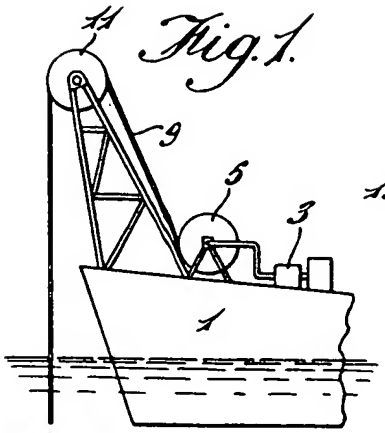


Fig. 2.

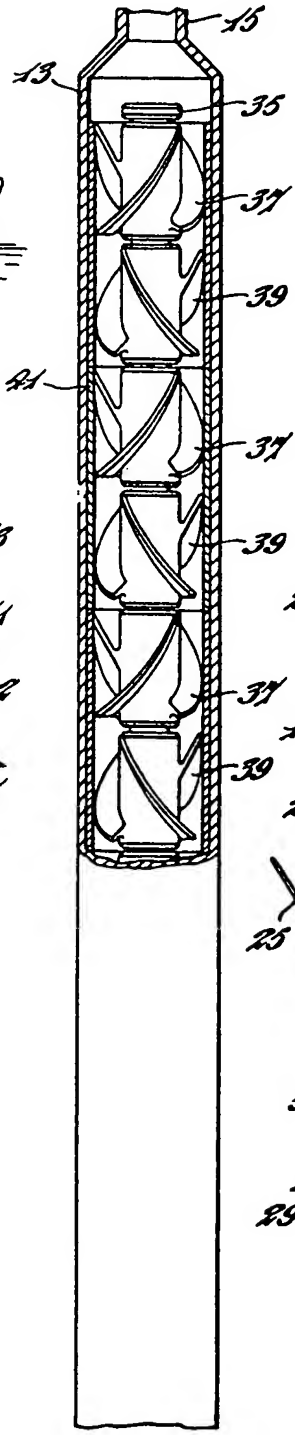
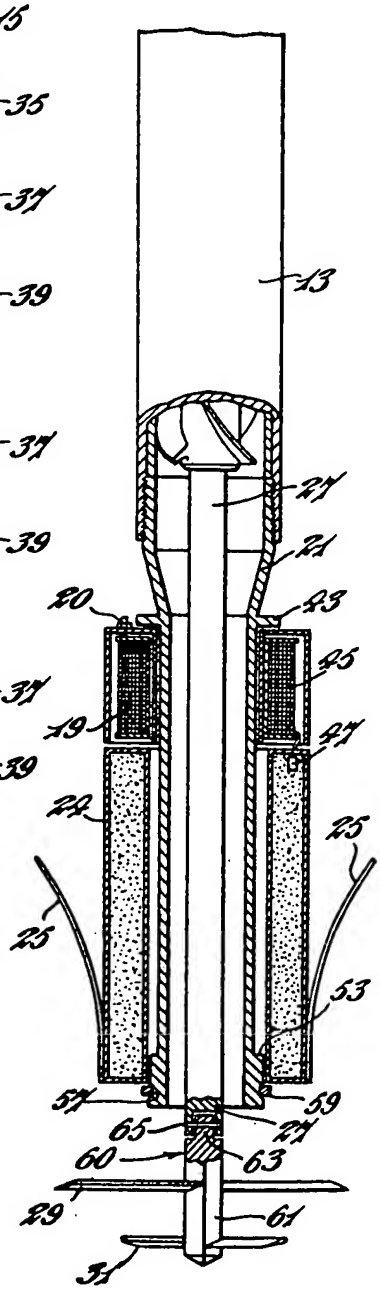


Fig. 3.



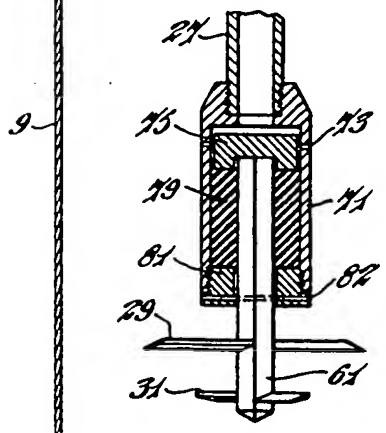


Fig. 4.